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(71) Applicant(s)
NEC Corporation

(Incorporated in Japan)

33-1 Shiba 5-chome, Minato-ku, Tokyo, Japan

(72) Inventor(s)
Isao Suzuki

(74) Agent and/or Address for Service
Mathys & Squire
100 Grays Inn Road, LONDON, WC1X 8AL,
United Kingdom

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EP 0512789 A2 EP 0453726 A2 US 4903212 A
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(54) **Mobile telephone measuring channel condition at time intervals depending on velocity**

(57) A mobile communication terminal has a GPS receiver and detects a movement velocity of the terminal based on GPS data. The electric field level of a radio channel being used and neighbouring channels in the same or adjacent cells are monitored, the neighbouring channels being monitored at time intervals which are changed according to the movement velocity. The lower the movement velocity, the longer the period of time between which the radio channels are intermittently monitored. When the mobile is stationary, monitoring may be halted. Thus battery power consumption and unnecessary switching due to multipath fading can be reduced. The duration of the actual channel electric field level measurement is kept constant regardless of the velocity. Channel switching is performed from a radio channel being used to a neighbouring radio channel when the channel electric field level of the neighbouring radio channel is better than that of the radio channel being used.

FIG.4

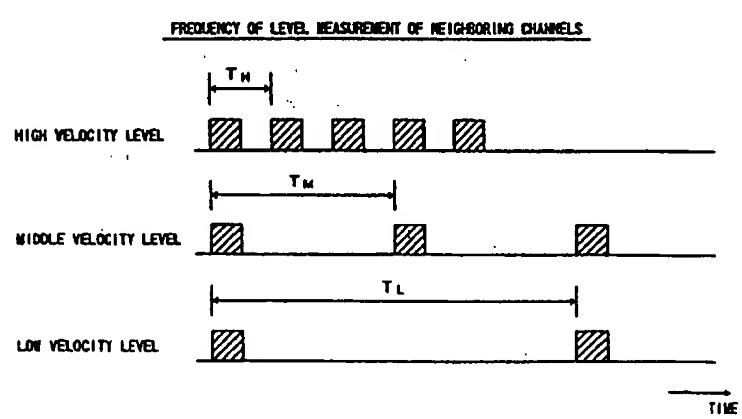

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FIG.1 (PRIOR ART)

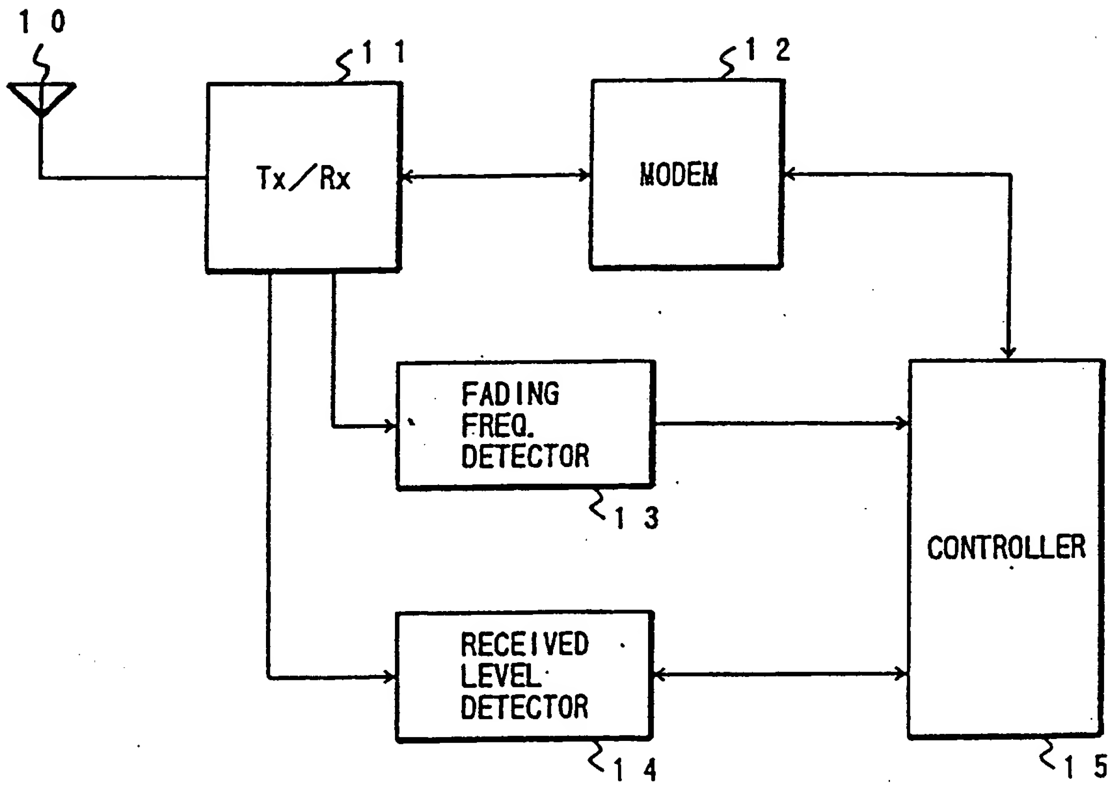


FIG. 2

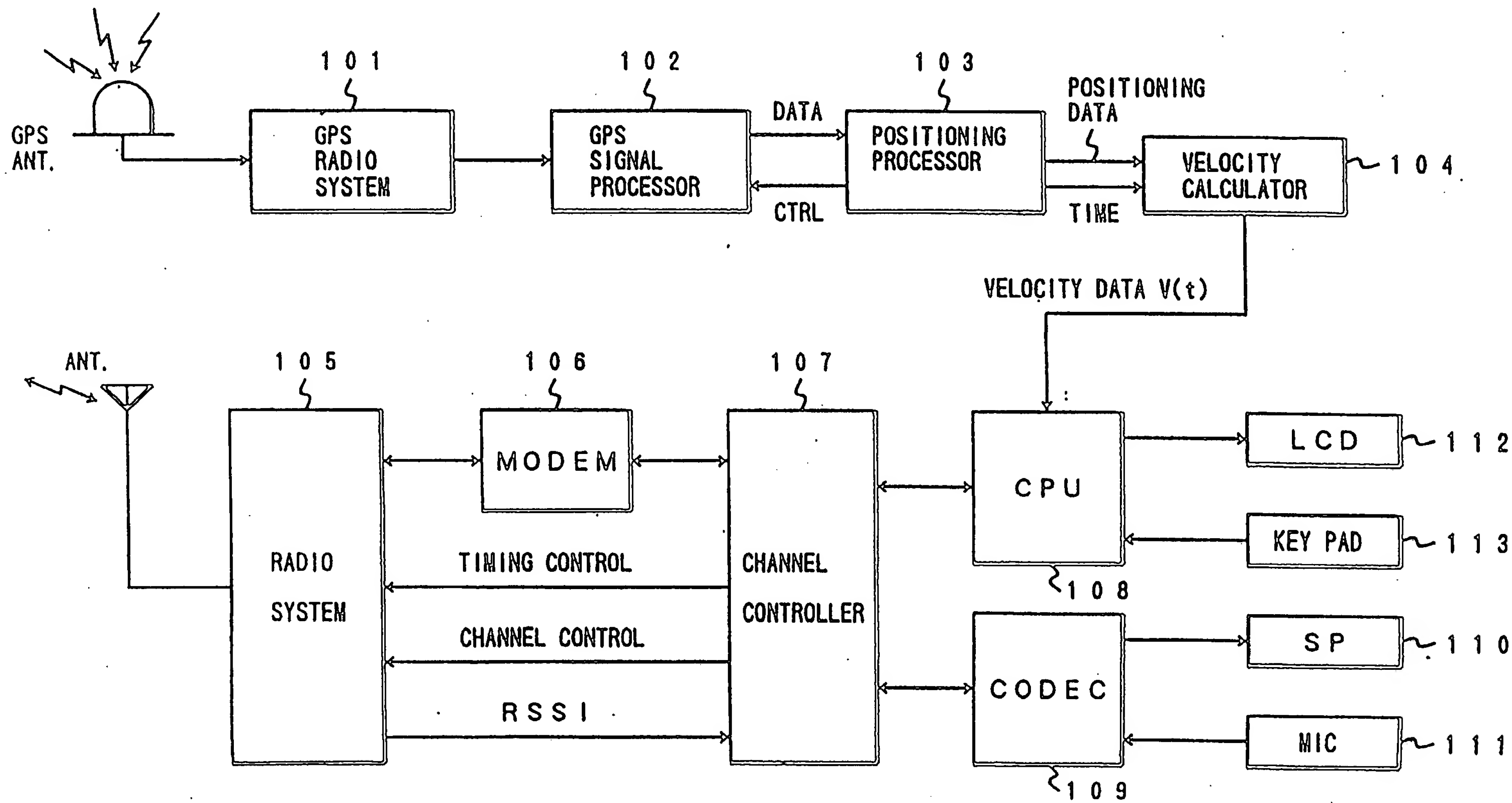

GPS ANT.
101
GPS RADIO SYSTEM
102
GPS SIGNAL PROCESSOR
DATA
CTRL
103
POSITIONING PROCESSOR
POSITIONING DATA
TIME
VELOCITY CALCULATOR
104
VELOCITY DATA V(t)
ANT.
105
RADIO SYSTEM
106
MODEM
107
CHANNEL CONTROLLER
TIMING CONTROL
CHANNEL CONTROL
RSSI
CPU
108
CODEC
109
LCD
112
KEY PAD
113
SP
110
MIC
111

FIG.3

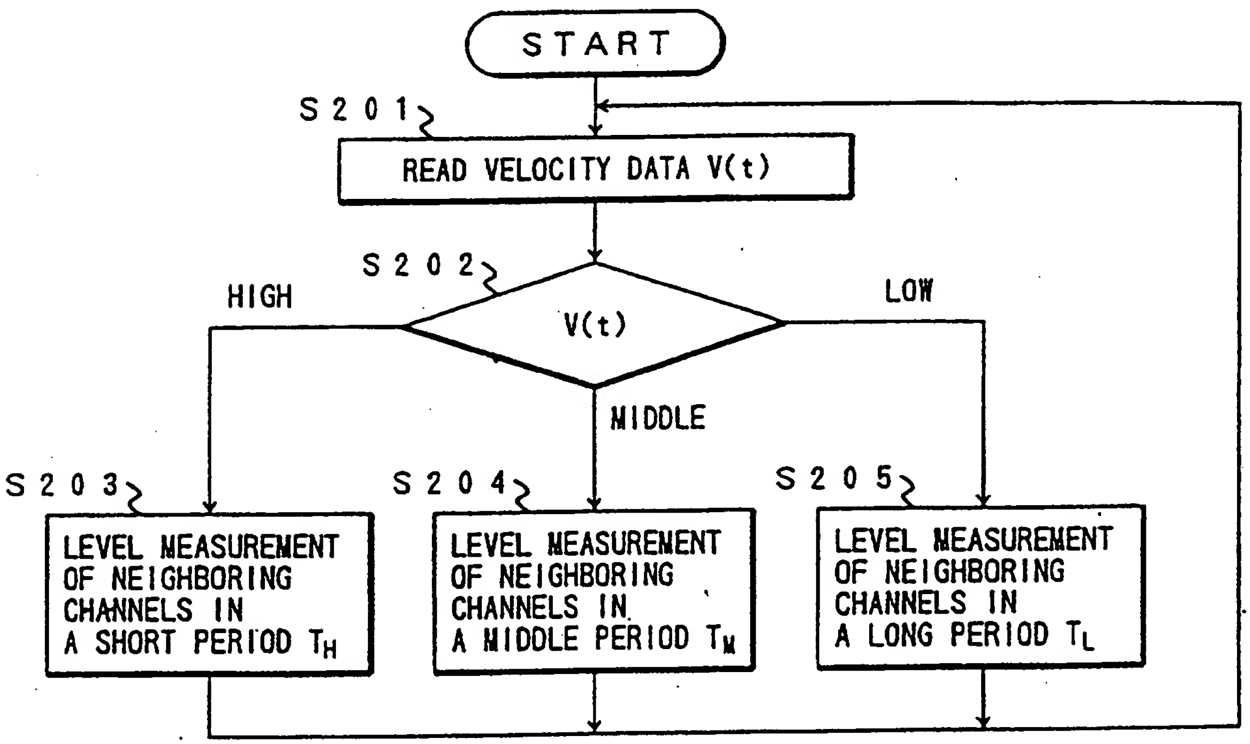

START
S201
READ VELOCITY DATA V(t)
S202
V(t)
HIGH
MIDDLE
LOW
S203
LEVEL MEASUREMENT OF NEIGHBORING CHANNELS IN A SHORT PERIOD T_H
S204
LEVEL MEASUREMENT OF NEIGHBORING CHANNELS IN A MIDDLE PERIOD T_M
S205
LEVEL MEASUREMENT OF NEIGHBORING CHANNELS IN A LONG PERIOD T_L

FIG. 4

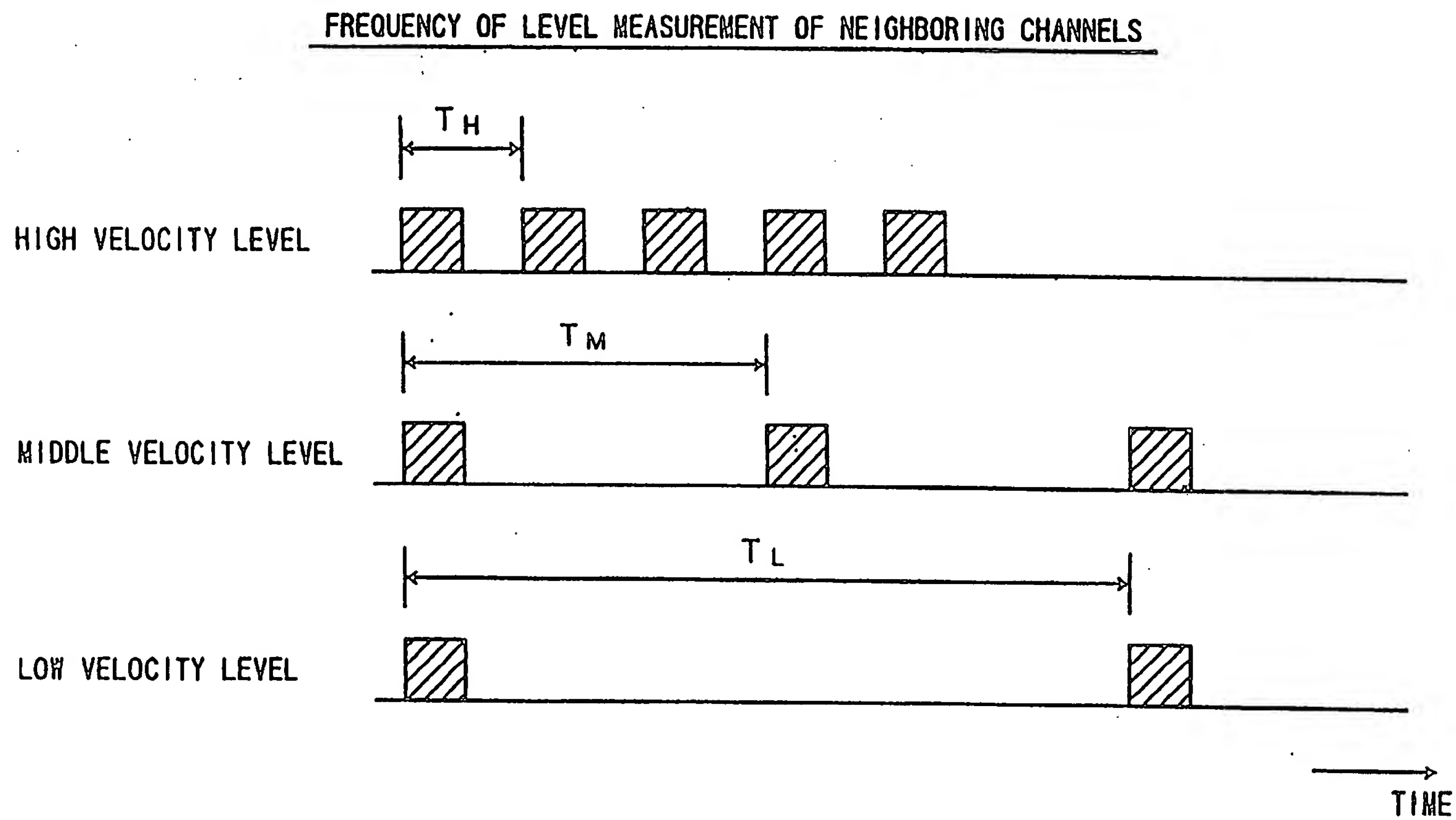

FREQUENCY OF LEVEL MEASUREMENT OF NEIGHBORING CHANNELS
T_H
HIGH VELOCITY LEVEL
T_M
MIDDLE VELOCITY LEVEL
T_L
LOW VELOCITY LEVEL
TIME

FIG.5

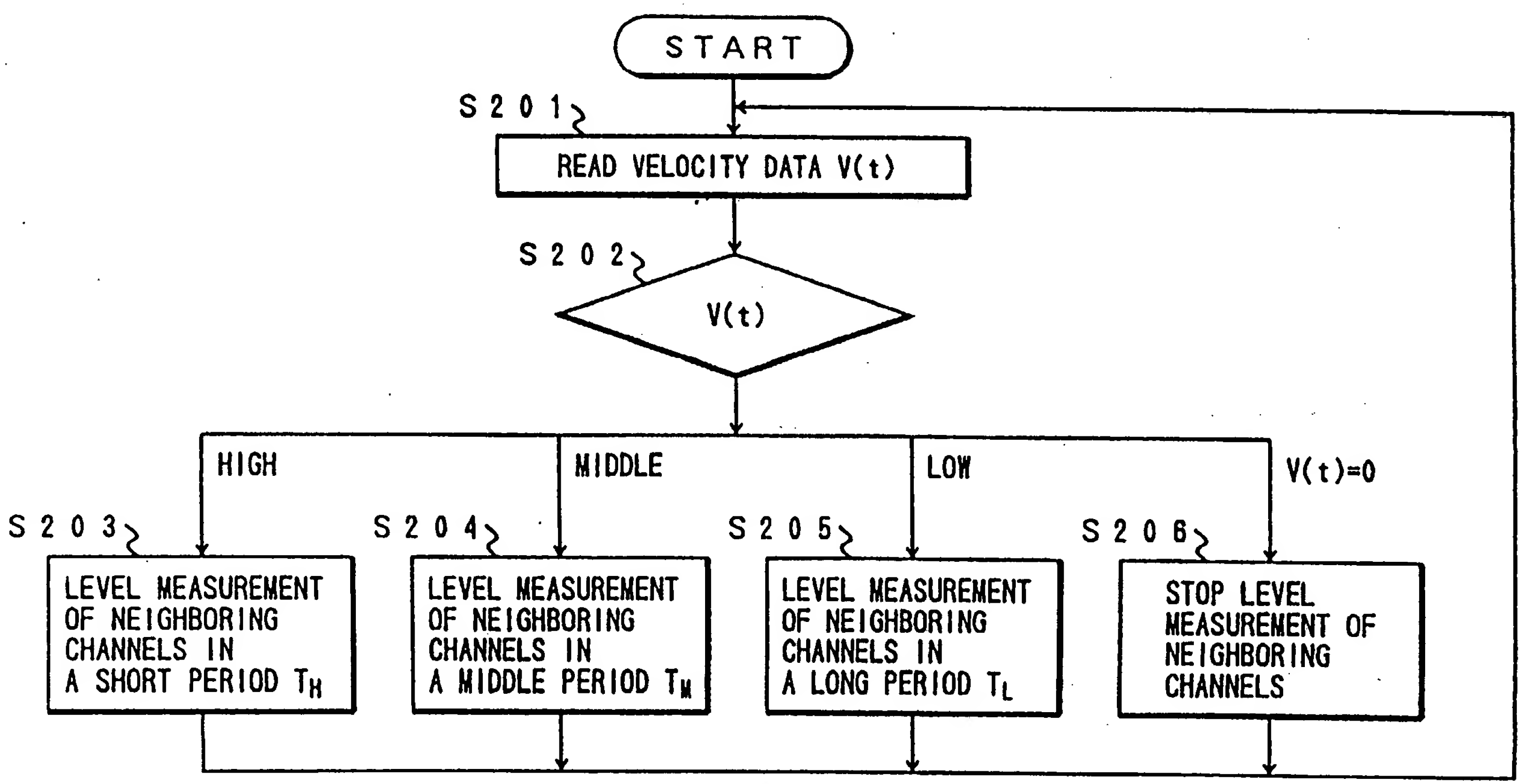
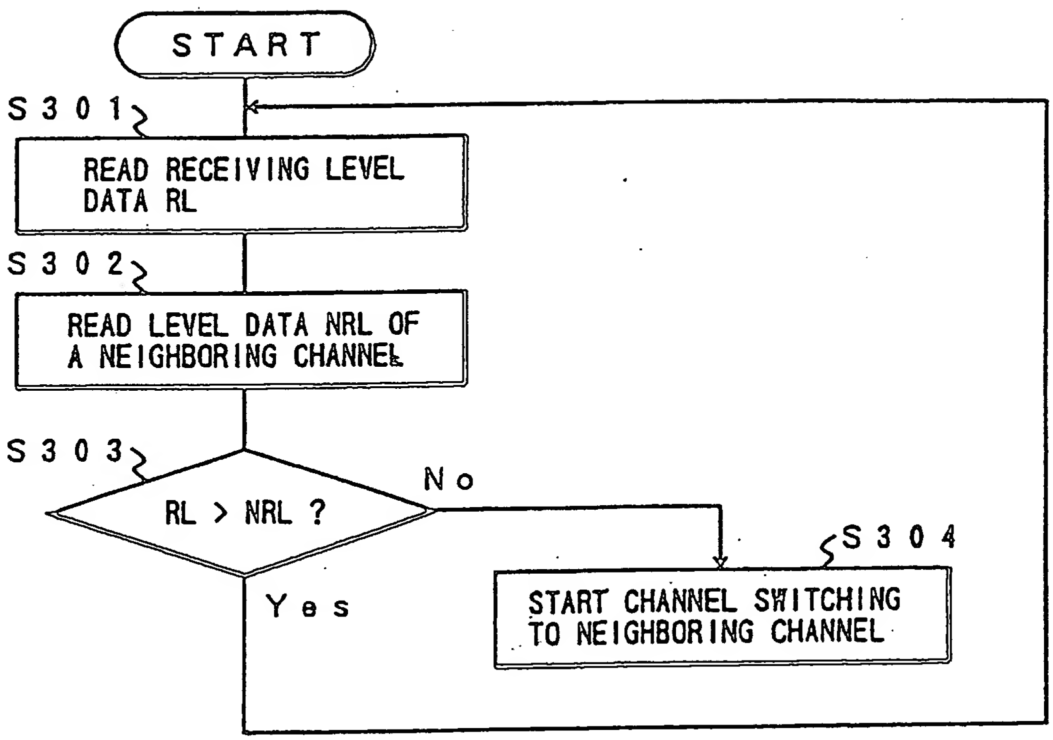

START
S201
READ VELOCITY DATA V(t)
S202
V(t)
HIGH
MIDDLE
LOW
V(t)=0
S203
LEVEL MEASUREMENT OF NEIGHBORING CHANNELS IN A SHORT PERIOD T_H
S204
LEVEL MEASUREMENT OF NEIGHBORING CHANNELS IN A MIDDLE PERIOD T_M
S205
LEVEL MEASUREMENT OF NEIGHBORING CHANNELS IN A LONG PERIOD T_L
S206
STOP LEVEL MEASUREMENT OF NEIGHBORING CHANNELS

FIG.6


START
S301
READ RECEIVING LEVEL DATA RL
S302
READ LEVEL DATA NRL OF A NEIGHBORING CHANNEL
S303
RL > NRL ?
No
Yes
S304
START CHANNEL SWITCHING TO NEIGHBORING CHANNEL

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MOBILE COMMUNICATION TERMINAL

The present invention generally relates to a cellular communication system, and in particular to a method for monitoring radio channels for channel switching in a mobile communication terminal such as a cellular telephone.

In cellular communications, it is necessary to transfer a connection from one cell to another without interruption. For this end, a mobile terminal monitors radio channels of adjacent cells at all times and, when the condition of a radio channel being used worsens and that of an adjacent radio channel improves, the mobile terminal changes the communication channel to the adjacent radio channel having the better radio channel condition.

One of methods of monitoring radio channels when the mobile terminal is moving has been disclosed in Japanese Patent Unexamined Publication No. 3-104330. In this method, the duration of the measurement of the strength level of a received signal is varied according to an estimated velocity of the moving mobile terminal. As shown in Fig. 1, a mobile terminal has a transmission and reception system including an antenna 10, a radio transmitter-receiver 11, and a modulator-demodulator 12. The mobile terminal is further provided with a fading frequency detector 13, a received level

detector 14, and a controller 15.

The fading frequency detector 13 detects a fadino frequency which is used to estimate a velocity of the mobile terminal by the controller 15. More specifically, the fading frequency detector 13, receiving an intermediate frequency signal from the radio transmitter-receiver 11, detects the envelope of an received signal strength. By comparing it with a predetermined threshold level, the fading frequency detector 13 counts the number of times the envelope has decreased below the predetermined threshold level for a predetermined time period to produce the fading frequency. When the fading frequency is low, it is estimated that the mobile terminal is moving at a relatively low velocity. Contrarily, when the fading frequency is high, it is estimated that the mobile terminal is moving at a relatively high velocity.

Based on the estimated velocity, the duration of the measurement of the strength level of a received signal is changed. At a low velocity, the measuring duration is long enough to produce a significant averaged level of the strength level of the received signal. On the other hand, at a high velocity, the measuring duration is short so as to rapidly determine the transfer from one cell to another.

However, the velocity estimation mentioned above is not able to assure continued accuracy because the received signal strength varies not only with the velocity of the movement of the mobile terminal but also multipath fading which is a characterization of radio propagation. More specifically, variations in received signal

strength due to the multipath fading cause the fading frequency to be changed, resulting in reduced accuracy of the velocity estimation based on the fading frequency. This causes undesired channel switching in a radio zone or a delay in transferring from one radio zone to another. In this manner, according to the conventional control method, it is difficult to transfer a connection with reliability. Further, since the measuring duration is relatively long at a low velocity, the power consumption is increased.

An object of at least the preferred embodiments of the present invention is to provide a communication control method which is able to achieve the optimized channel monitoring for reliable switching to another radio channel regardless of the velocity of a mobile terminal.

Another such object is to provide a mobile terminal which is able to achieve the reliable channel switching whilst saving battery power at any velocity of the mobile terminal.

Still another such object is to provide a cellular telephone which is able to achieve an improved communication quality regardless of the velocity of the cellular telephone.

In a first aspect, the present invention provides a method of monitoring a channel condition of a radio channel in a mobile terminal, said method comprising the steps of:

receiving GPS (Global Positioning System) data;

detecting a movement velocity of the mobile terminal based on the GPS data; and

monitoring periodically the channel condition, the periodicity of said monitoring being varied with the movement velocity of the mobile terminal whilst the duration of each periodic monitoring of the channel condition is maintained at a constant value.

A second aspect of the present invention provides a method of monitoring a channel condition of a radio channel in a mobile terminal located in a communication area divided into a plurality of smaller radio zones, said method comprising the steps of:

a) receiving GPS (Global Positioning System) data from at least three GPS satellites;

b) detecting a movement velocity of the mobile terminal based on the GPS data;

c) changing a time period according to the movement velocity of the mobile terminal; and

d) monitoring periodically the channel condition with said time period, the time period being varied according to the movement velocity of the mobile terminal whilst a constant duration of monitoring the channel condition for each period.

According to a preferred embodiment of the present invention, a mobile

communication terminal is provided with a GPS (Global Positioning System) receiver wherein a movement velocity of the mobile communication terminal is obtained based on GPS data received by the GPS receiver. The period of time in which the channel condition of a radio channel is monitored is changed according to the movement velocity. Since the GPS data provides an accurate position of the mobile communication terminal, an accurate movement velocity of the mobile communication terminal is obtained regardless of cellular radio propagation characterization. The radio channel is periodically monitored in a period of time determined according to the accurate movement velocity of the mobile communication terminal. More specifically, the lower the movement velocity of the mobile communication terminal, the longer the period of time in which the radio channel is intermittently monitored.

A third aspect of the present invention provides in a mobile communication terminal located in a communication area divided into a plurality of radio zones, a method of monitoring channel conditions of a first radio channel of a first radio zone being used by said terminal and a second radio channel of a second radio zone adjacent to the first radio zone, the method comprising the steps of:

a) receiving GPS (Global Positioning System) data from at least three GPS satellites;

b) detecting a movement velocity of the mobile communication terminal based on the GPS data;

c) changing a time period according to the movement velocity of the mobile communication terminal; and

d) monitoring periodically the channel condition of the second radio channel, the period of said monitoring being changed according to the movement velocity of the mobile communication terminal whilst the duration of each periodic monitoring of the channel condition is maintained at a constant value.

According to a preferred embodiment of this aspect of the present invention, in a mobile terminal which is located in a communication area divided into a plurality of smaller radio zones, the GPS data are received from at least three GPS satellites and a movement velocity of the mobile terminal is detected based on the GPS data. Changing an intermittent period according to the movement velocity of the mobile terminal, the channel condition is monitored in the intermittent period with a constant duration of monitoring the channel condition for each intermittent period. By comparing the channel condition of a first radio

channel being used to that of a second radio channel, channel switching is performed form the first radio channel to the second radio channel when the channel condition of the second radio channel is better than that of the first radio channel.

Preferably, the intermittent period becomes longer as the movement velocity of the mobile terminal is reduced. In other words, the intermittent period becomes shorter as the movement velocity of the mobile terminal is increased.

In a fourth aspect, the present invention provides a mobile communication terminal comprising:

communication means for communicating with a nearby base station;

receiving means for receiving GPS (Global Positioning System) data from at least three GPS satellites;

detecting means for detecting a movement velocity of the mobile communication terminal based on the GPS data;

communication control means for changing a time period according to the movement velocity of the mobile communication terminal; and

monitoring means for monitoring channel conditions of a first radio channel being used by the mobile communication terminal and a second radio channel, a channel condition of the second radio channel being monitored periodically, the time period of said monitoring being changeable according to the movement velocity of the mobile communication terminal whilst maintaining the duration of monitoring the channel condition of a constant value, and for switching from the first radio channel to the second radio channel when the channel condition of the second radio channel is superior to that of the first radio channel.

According to a preferred embodiment of this aspect of the present invention, a mobile communication terminal periodically monitors channel conditions of a first radio channel of a first radio zone being used and a second radio channel of a second radio zone adjacent to the first radio zone. After detecting a movement velocity of the mobile terminal based on the GPS data as described above, the mobile communication terminal changes an intermittent period according to the movement velocity thereof and monitors the channel condition of the second radio channel in the intermittent period changed with a constant duration of monitoring the channel condition for each intermittent period.

It is preferable that the channel condition of the second radio channel is not monitored

when the movement velocity of the mobile communication terminal is zero.

Further preferably, in addition to the intermittent period, a whole monitoring time period may be changed according to the movement velocity of the mobile communication terminal. The channel condition of the second radio channel is monitored in the intermittent period for the whole time period which has been changed according to the movement velocity of the mobile communication terminal.

In a fifth aspect the present invention provides a cellular telephone comprising:

a GPS (Global Positioning System) receiver for receiving GPS data from at least three GPS satellites;

detecting means for detecting a movement velocity of the mobile communication terminal based on the GPS data;

control means for changing a time period according to the movement velocity of the mobile communication terminal, monitoring channel conditions of a first radio channel and a second radio channel, the channel condition of the second radio channel being monitored periodically with said time period, said time period being changeable according to the movement velocity of the mobile communication terminal whilst maintaining the duration of the monitoring at a constant value, and for switching from the first radio channel to the second radio channel when the channel condition of the second radio channel is superior to that of the first radio channel.

Preferred features of the present invention will now be described, purely by way of example only, with reference to the accompanying drawings, in which:-

Fig. 1 is a block diagram showing a conventional mobile terminal;

Fig. 2 is a block diagram showing a cellular telephone which is an embodiment of a mobile terminal according to the present invention;

Fig. 3 is a flowchart showing a first embodiment of a channel monitoring method according to the present invention;

Fig. 4 is a time chart showing the level monitoring frequency in neighbouring radio channels with respect to the movement velocity of the mobile terminal;

Fig. 5 is a flowchart showing a second embodiment of a channel monitoring method according to the present invention; and

Fig. 6 is a flowchart showing a level comparison procedure according to the present invention.

In cellular communications, the communication area is divided into smaller areas, called cells or radio zones, wherein a mobile terminal communicates with a nearby base station through a radio channel. The mobile terminal and/or the base station measures signal strength in both a radio channel being used and another radio channel of an adjacent cell and, when the condition of the adjacent channel is better than that of the radio channel being used, the connection is transferred from the radio channel to the adjacent radio channel. The details of a cellular telephone as an example of the mobile terminal will be described hereinafter.

Referring to Fig. 2, a battery-powered cellular telephone according to an embodiment of the present invention is provided with a GPS (Global Positioning System). In the GPS system, a GPS radio system 101 receives GPS signals from GPS satellites through a GPS antenna and demodulates the GPS signals into GPS baseband signals. Receiving the GPS baseband signals from the GPS radio system 101, a GPS signal processor 102 decodes them to necessary GPS data including satellite ID codes, orbit information of each satellite, atomic clock information, and delay correction data. A positioning processor 103 calculates the relative position of the cellular telephone based on GPS data of at least three GPS satellites using a well-known positioning procedure, and then outputs the positioning data to a velocity calculator 104. The velocity calculator 104 receives the positioning data at predetermined intervals and calculates a movement velocity of the cellular telephone using the positioning data and time information.

The obtained velocity data is used to control the period of time in which signal strength in radio channels is monitored as described later.

The cellular telephone is further comprised of a radio system 105, a modem (modulator and demodulator) 106, a channel controller 107, a processor 108, and other necessary elements including a codec (encoder and decoder) 109, a speaker 110, a microphone 111, a display 112, and a keypad 113. The radio system 105 includes a radio transmitter and a radio receiver to communicate with a nearby base station through a radio channel. A channel changing control and an intermittent receiving control are performed by the channel controller 107 under the control of the processor 108. The electric field level of a radio channel is detected by the radio system 105 and is output to the channel controller 107 where the electric field level is used to determine whether to change to another radio channel within a radio zone or between adjacent radio zones. That is, the radio channel being used.and adjacent radio channels are monitored while scanning.

The processor 108 previously stores a predetermined number of velocity levels which are compared to the calculated velocity received from the velocity calculator 104. According to a detected velocity level into which the calculated velocity falls, the processor 108 determines an intermittent period of time in which the electric field level of an adjacent radio channel is monitored. The channel controller 107 controls the radio system 105 such that radio signals in adjacent radio channels are

intermittently received and their electric field levels are detected in the determined period of time.

In this embodiment, the processor 108 stores three velocity levels: high, middle, and low. The lower the velocity level, the longer the period of time in which the radio channels are periodically monitored while the duration of receiving for channel monitoring is kept constant. In cases where the calculated velocity is zero, that is, the cellular telephone stops at a location within a radio zone, it is preferable that the processor 108 stops the channel controller 107 monitoring adjacent radio channels so as to save the battery power. These operations of the cellular telephone will be described in detail hereinafter.

Referring to Fig. 3, when reading the calculated velocity data V(t) from the velocity calculator 104 (step S201), the processor 108 determines a velocity level of the received velocity data V(t) by comparing it to the previously set velocity levels: high, middle, and low (step S202). When the calculated velocity data-V(t) is in the high velocity level, the processor 108 sets the intermittent period of level measurement of adjacent channels to a predetermined short period T_H (step S203). The channel controller 107 controls the radio system 105 such that radio signals in adjacent radio channels are intermittently received and their electric field levels are detected in the short period T_H. When the calculated velocity data V(t) is in the middle velocity level, the processor 108 sets the intermittent period of level measurement of adjacent channels to a predetermined

middle period T_M (step S204). The channel controller 107 controls the radio system 105 such that radio signals in adjacent radio channels are intermittently received and their electric field levels are detected in the middle period T_M. When the calculated velocity data V(t) is in the low velocity level, the processor 108 sets the intermittent period of level measurement of adjacent channels to a predetermined long period T_L (step S205). The channel controller 107 controls the radio system 105 such that radio signals in adjacent radio channels are intermittently received and their electric field levels are detected in the long period T_L. In this manner, the intermittent period of level measurement in adjacent channels is varied according to a detected velocity level as shown in Fig. 4.

Referring to Fig. 4, the higher the velocity level, the shorter the intermittent period of measurement of electronic field strength level. In other words, the lower the velocity level, the lower the number of times neighboring channels are monitored. In cases where the velocity level is low, the neighboring channels are monitored in a long period of time so as to avoid undesirable channel switch due to multipath fading and the likes. The duration time of level measurement is constant at any velocity level in this embodiment, which is determined to be long enough to average a fading signal having a relatively long period at the low velocity level.

It is further preferred that the whole period of measurement of electronic field strength level becomes shorter

as the velocity level is increased. Such a method allows a fading signal having a relatively long period at the low velocity level to be sufficiently averaged, so that the undesirable channel switch is prevented when a received level change due to fading suddenly occurs, resulting in further increased reliability of channel switching.

In cases where the cellular telephone stops at a location within a radio zone, the processor 108 may stop the channel controller 107 monitoring adjacent radio channels so as to save the battery power. As shown in Fig. 5, where the steps S201-S205 are similar to those previously described with reference to Fig. 3, when the processor 108 reads the velocity data V(t)=0 from the velocity calculator 104 (S201, S202), the processor 108 stops the channel controller 107 monitoring adjacent radio channels (S206).

Under the control of the processor 108, the channel controller 107 monitors the radio channel being used and further monitors adjacent radio channels in the period of time determined by the processor 108.

Referring to Fig. 6, the channel controller 107 reads the electronic field level data RL of the radio channel being used from the radio system 105 (S301) and then further reads the electric field level data NRL of a neighboring radio channel from the radio system 105 (S302). When RL > NRL, that is, the radio channel being used is better than the neighboring channel (Yes in step S303), the radio channel being used is held and the control

goes back to the step S301. When RL is not greater than NRL, that is, the radio channel being used is not better than the neighboring channel (No in step S303), the channel controller 107 starts a predetermined channel switching procedure of switching the radio channel being used to the neighboring channel (step S304).

In cases where the cellular telephone stops at a location within a radio zone, the processor 108 may stop the channel controller 107 monitoring adjacent radio channels. In this case, the channel controller 107 does not read the electric field level data NRL of a neighboring radio channel from the radio system 105.

Each feature disclosed in this specification (which term includes the claims) and/or shown in the drawings may be incorporated in the invention independently of other disclosed and/or illustrated features.

The text of the abstract filed herewith is repeated here as part of the specification.

A mobile communication terminal is provided with a GPS receiver and detects a movement velocity of the mobile communication terminal based on GPS data. The period of time in which the channel condition of a radio channel is monitored is changed according to the movement velocity. The lower the movement velocity of the mobile communication terminal, the longer the period of time in which the radio channel is intermittently monitored. The radio channel is periodically monitored in a period of time changed according to the movement velocity of the mobile communication terminal. Channel switching is performed from a radio channel being used to a neighbouring radio channel when the channel condition of the neighbouring radio channel is better than that of the radio channel being used.

CLAIMS

1. A method of monitoring a channel condition of a radio channel in a mobile terminal, said method comprising the steps of:

receiving GPS (Global Positioning System) data;

detecting a movement velocity of the mobile terminal based on the GPS data; and

monitoring periodically the channel condition, the periodicity of said monitoring being varied with the movement velocity of the mobile terminal whilst the duration of each periodic monitoring of the channel condition is maintained at a constant value.

2. A method of monitoring a channel condition of a radio channel in a mobile terminal located in a communication area divided into a plurality of radio zones, said method comprising the steps of:

a) receiving GPS (Global Positioning System) data from at least three GPS satellites;

b) detecting a movement velocity of the mobile terminal based on the GPS data;

c) changing a time period according to the movement velocity of the mobile terminal; and

d) monitoring periodically the channel condition with said time period, the time period being varied according to the movement velocity of the mobile terminal with a constant duration of monitoring the channel condition for each period.

3. The method according to Claim 2, further comprising the step of:

e) comparing the channel condition of a first radio channel to that of a second radio channel, the first radio channel being that used by the mobile terminal; and

f) switching from the first radio channel to the second radio channel when the channel condition of the second radio channel is superior to that of the first radio channel.

4. The method according to Claim 2 or 3, wherein, in the step c), the period increases as the movement velocity of the mobile terminal decreases.

5. The method according to any of Claims 2 to 4; wherein:

the step c) comprises the step of changing a whole monitoring time period, according to the movement velocity of the mobile terminal; and

the step d) comprises the step of monitoring the channel condition for the whole monitoring time period.

6. In a mobile communication terminal located in a communication area divided into a plurality of radio zones, a method of monitoring channel conditions of a first radio channel of a first radio zone being used by said terminal and a second radio channel of a second radio zone adjacent to the first radio zone, the method comprising the steps of:

a) receiving GPS (Global Positioning System) data from at least three GPS satellites;

b) detecting a movement velocity of the mobile communication terminal based on the GPS data;

c) changing a time period according to the movement velocity of the mobile communication terminal; and

d) monitoring periodically the channel condition of the second radio channel, the period of said monitoring being changed according to the movement velocity of the mobile communication terminal whilst the duration of each periodic monitoring of the channel condition is maintained at a constant value.

7. The method according to Claim 6, further comprising the step of:

e) comparing the channel condition of the first radio channel to that of the second radio channel; and

f) switching from the first radio channel to the second radio channel when the channel condition of the second radio channel is superior to that of the first radio channel.

8. The method according to Claim 6 or 7, wherein, in the step c) the time period increases as the movement velocity of the mobile communication terminal decreases.

9. A method according to Claim 6 or 7, wherein the channel condition of the second radio channel is not monitored when the movement velocity of the mobile communication terminal is zero.

10. A mobile communication terminal comprising:

communication means for communicating with a nearby base station;

receiving means for receiving GPS (Global Positioning System) data from at least three GPS satellites;

detecting means for detecting a movement velocity of the mobile communication terminal based on the GPS data;

communication control means for changing a time period according to the movement velocity of the mobile communication terminal; and

monitoring means for monitoring channel conditions of a first radio channel being used by the mobile communication terminal and a second radio channel, a channel condition of the second radio channel being monitored periodically, the time period of said monitoring being changeable according to the movement velocity of the mobile communication terminal whilst maintaining the duration of monitoring the channel condition of a constant value, and for switching from the first radio channel to the second radio channel when the channel condition of the second radio channel is superior to that of the first radio channel.

11. The mobile communication terminal according to Claim 10, wherein the communication control means is adapted to increase the time period as the movement velocity of the mobile communication terminal is decreased.

12. The mobile communication terminal according to Claim 10 or 11, wherein:

the communication control means is adapted to change a whole monitoring time period, in addition to the time period, in addition to the time period, according to the movement velocity of the mobile communication terminal; and

the monitoring means is adapted to monitor periodically the channel condition of the second radio channel for the whole time period.

13. A cellular telephone comprising:

a GPS (Global Positioning System) receiver for receiving GPS data from at least three GPS satellites;

detecting means for detecting a movement velocity of the mobile communication terminal based on the GPS data;

control means for changing a time period according to the movement velocity of the mobile communication terminal, monitoring channel conditions of a first radio channel and a second radio channel, the channel condition of the second radio channel being monitored periodically, the period of said monitoring being changeable according to the movement velocity of the mobile communication terminal with the duration of the monitoring being maintained at a constant value, and for switching from the first radio channel to the second radio channel when the channel condition of the second radio channel is superior to that of the first radio channel.

14. A method of monitoring a channel condition substantially as herein described with reference to Figure 3, 5 or 6 of the accompanying drawings.

15. A mobile communication terminal substantially as herein described and as shown in Figure 2 of the accompanying drawings.

The Patent Office

17

Application No: GB 9620317.9
Claims searched: All

Examiner: Gareth Griffiths
Date of search: 8 January 1997

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): H4L (LDSH, LDSJ, LDSL, LECTP, LFM), H4D (DAB, DPBC)

Int Cl (Ed.6): G01S 5/14, H04B 17/00, H04Q 7/32, 7/38

Other: Online Database: WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
Y	EP 0512789 A2 (NAVSYS) col.4 line 13 - col.5 line 6	1-4, 6-8, 10, 11, 13
Y	EP 0453726 A2 (PIONEER) whole document	1-4, 6-8, 10, 11, 13
Y	US 4903212 (YOKOUCHI) col.3 line 65 - col.4 line 2	1-4, 6-8, 10, 11, 13
Y	WPI Abstract Accession No. 91-173933/24 & JP030104330 (NTT) 19.09.89 (see abstract)	1-4, 6-8, 10, 11, 13

X Document indicating lack of novelty or inventive step
Y Document indicating lack of inventive step if combined with one or more other documents of same category.
& Member of the same patent family
A Document indicating technological background and/or state of the art.
P Document published on or after the declared priority date but before the filing date of this invention.
E Patent document published on or after, but with priority date earlier than, the filing date of this application.